

What is claimed:

1. A catalyst, comprising:

at least 50 wt.% of an oxide support selected from the group consisting of activated alumina, zirconia, titania, silica, zeolites, and combinations thereof;  
at least 5 wt.% copper or an oxide thereof dispersed on the oxide support;  
0.01 to 0.5 wt.% of a platinum group metal selected from the group consisting of platinum, palladium, rhodium, osmium, iridium, ruthenium and combinations thereof dispersed on the oxide support; and  
at least 10 wt.% of a reducible metal oxide selected from the group consisting of the oxides of chromium, vanadium, molybdenum, cerium, praseodymium, neodymium, titanium, nickel, manganese, cobalt and combinations thereof dispersed on the oxide support.

2. The catalyst of claim 1, wherein the reducible metal oxide comprises cerium oxide.

3. The catalyst of claim 1, wherein the oxide support comprises activated alumina.

4. The catalyst of claim 1, wherein the platinum group metal comprises platinum.

5. A catalyst, comprising:

at least 50 wt.% of an alumina support;  
at least 5 wt.% copper or an oxide thereof dispersed on the alumina support;  
0.01 to 0.5 wt.% of a platinum group metal selected from the group consisting of platinum, palladium, rhodium, osmium, iridium, ruthenium and combinations thereof dispersed on the alumina support; and  
at least 10 wt.% cerium oxide dispersed on the alumina support.

6. The catalyst of claim 5, wherein the platinum group metal comprises platinum.

7. The catalyst of claim 6, wherein there is

at least 65 wt.% of the alumina support;  
6 to 12 wt.% of copper or an oxide thereof dispersed on the alumina support;  
0.01 to 0.5 wt.% of platinum on the alumina support; and

- 10 to 25 wt.% of cerium oxide dispersed on the alumina support.
8. The catalyst of claim 5, wherein the catalyst is in the form of particles having a mesh size of 12 or greater, and a BET surface area of  $10 \text{ m}^2/\text{g}$  or greater.
  9. The catalyst of claim 5, wherein the catalyst is in the form of a washcoat composition deposited on a monolith substrate.
  10. A water-gas shift catalyst for converting carbon monoxide and steam into hydrogen and carbon dioxide, comprising
    - at least 50 wt.% of an alumina support;
    - at least 5 wt.% copper or an oxide thereof dispersed on the alumina support;
    - 0.01 to 0.5 wt.% of a platinum group metal selected from the group consisting of platinum, palladium, rhodium, osmium, iridium, ruthenium and combinations thereof dispersed on the alumina support; and
    - at least 10 wt.% cerium oxide dispersed on the alumina support.
  11. The water-gas shift catalyst of claim 10, wherein the platinum group metal comprises platinum.
  12. The water-gas shift catalyst of claim 11, wherein there is
    - at least 65 wt.% of the alumina support;
    - 6 wt.% to 12 wt.% of copper or an oxide thereof dispersed on the alumina support;
    - 0.01 to 0.5 wt.% of platinum on the alumina support; and
    - 10 to 25 wt.% of cerium oxide dispersed on the alumina support.
  13. The water-gas shift catalyst of claim 10, wherein the alumina support is in the form of particles having a mesh size of 12 or greater, and a BET surface area of  $10 \text{ m}^2/\text{g}$  or greater.
  14. A catalyst, comprising:
    - a cerium oxide support;

copper or an oxide thereof dispersed on the cerium oxide support; and  
0.1 wt.% or more of a platinum group metal selected from the group consisting of  
platinum, palladium, rhodium, osmium, iridium, ruthenium and  
combinations thereof dispersed on the cerium oxide support.

15. The catalyst of claim 14, wherein the platinum group metal comprises platinum.

16. The catalyst of claim 15, wherein there is:

4 wt. % to 12 wt.% of copper or an oxide thereof dispersed on the cerium oxide  
support; and

0.1 wt.% to 2 wt.% platinum dispersed on the cerium oxide support.

17. The catalyst of claim 14, wherein the catalyst is in the form of a washcoat  
composition deposited on a monolith substrate.

18. A water-gas shift catalyst for converting carbon monoxide and steam into hydrogen  
and carbon dioxide, comprising:

a cerium oxide support;

copper or an oxide thereof dispersed on the cerium oxide support; and

0.1 wt.% or more of a platinum group metal selected from the group consisting of  
platinum, palladium, rhodium, osmium, iridium, ruthenium and  
combinations thereof dispersed on the cerium oxide support.

19. The water-gas shift catalyst of claim 18, wherein the platinum group metal  
comprises platinum.

20. The water-gas shift catalyst of claim 19, wherein there is:

4 wt.% to 12 wt.% of copper or an oxide thereof dispersed on the cerium oxide  
support; and

0.1 wt.% to 2 wt. % platinum dispersed on the cerium oxide support.

21. The water-gas shift catalyst of claim 18, wherein the water-gas shift catalyst is in the  
form of a washcoat composition deposited on a monolith substrate.

22. An apparatus for supplying hydrogen to a PEM fuel cell with a hydrocarbon reformer reactor, a selective carbon monoxide oxidation reactor and a water-gas shift reactor having a water-gas shift catalyst, wherein the water-gas shift catalyst comprises:

at least 50 wt.% of an oxide support selected from the group consisting of activated alumina, zirconia, titania, silica, zeolites and combinations thereof;

copper or an oxide thereof dispersed on the oxide support;

0.01 to 0.5 wt.% of a platinum group metal selected from the group consisting of platinum, palladium, rhodium, osmium, iridium, ruthenium and combinations thereof dispersed on the oxide support; and

at least 10 wt.% of a reducible metal oxide selected from the group consisting of the oxides of chromium, vanadium, molybdenum, cerium, praseodymium, neodymium, titanium, nickel, manganese, cobalt and dispersed on the oxide support;

wherein the hydrocarbon reformer reactor is upstream and in train with the water-gas shift reactor, and the preferential oxidation catalyst is downstream and in train with the water-gas shift reactor.

23. An apparatus for supplying hydrogen to a PEM fuel cell with a hydrocarbon reformer reactor, a selective carbon monoxide oxidation reactor and a water-gas shift reactor having a water-gas shift catalyst, wherein the water-gas shift catalyst comprises:

a cerium oxide support;

copper or an oxide thereof dispersed on the cerium oxide support; and

0.1 wt.% or more of a platinum group metal selected from the group consisting of platinum, palladium, rhodium, osmium, iridium, ruthenium and combinations thereof dispersed on the cerium oxide support.

wherein the hydrocarbon reformer reactor is upstream and in train with the water-gas shift reactor, and the preferential oxidation catalyst is downstream and in train with the water-gas shift reactor.